## <u>Remarks</u>

Claims 1-2, 4-15, and 17-23 remain.

Claims 1, 2, 5-9, 15, 18-21, and 22-23 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Fukuzawa et al (US Publication Number 200210048690), in view of Nagahama et al (US Publication Number 200410144995). Claims 4, 10-14, and 17 have been rejected over Fukuzawa and Nagahama and further in view of one or more other references.

> The basis for the rejection of independent claims 1 and 9 is that Nagahama discloses:
>
> "An underlayer (figure 5, item 12) formed of a substantially chemically-ordered alloy having a tetragonal crystalline structure (paragraph 1, Body-centered cubic is tetragonal), the alloy selected from the group consisting of alloys of AuCu, FePt, FePd, AgTi3, Pt Zn, PdZn, IrV, Copt and PdCd, said underlayer allow further comprising at least one element selected from the group consisting of Pd, Fe, Pt, and Rh (paragraph 69)." (Office Action, pages 3-4)

However, Nagahama does not teach this, which will become clear from a comparison of Nagahama's Fig. 5 with Applicants' Fig. 2. Layer 2 in Nagahama's Fig. 5 corresponds to layer 206 in Applicants' Fig. 2. In each case this layer is the *ferromagnetic* layer that is directly adjacent the nonmagnetic spacer layer. The nonmagnetic spacer layer is located between the two ferromagnetic layers or "electrodes" and is the insulating layer 3 in the magnetic tunnel junction (MTJ) device of Nagahama or layer 208 in the Applicants' invention. (Layer 208 is either insulating if the device is a MTJ like Nagahama, or conducting if the device is a CPP-SV, as explained in the general background of Applicants' specification on page 2, lines 15-26).

Because layer 2 in Nagahama is the ferromagnetic electrode, underlayer 12 is an underlayer *directly beneath and in contact with the ferromagnetic electrode*. In contrast, in Applicants' invention the ferromagnetic electrode 206 is required to be "pinned" and so the layer directly beneath and in contact with it is the antiferromagnetic layer 205, which is the PtMn alloy or similar antiferromagnetic material. The underlayer referred to in Applicants' claims 1 and 9 is layer 204, which is the AuCu type of material *directly beneath and in contact with antiferromagnetic layer 205*.

An explanation of the different functions of layers 2-12-11 in Nagahama and layers 204-205-206 in Applicants' invention will hopefully establish the inapplicability of Nagahama as a

reference. Nagahama's paragraph 69 describes the layers 2-12-11 as an "artificial antiferromagnet". This is a relatively common term used to describe two ferromagnetic layers "antiferromagnetically" coupled across an antiferromagnetic coupling layer, which must be of a specific thickness and composition. The term 'artificial" is used because there is no direct antiferromagnetic effect at the interface but rather the magnetizations of the two ferromagnetic layers are *antiparallel* because the antiferromagnetic coupling layer has a specific thickness and composition. (An example of an artificial antiferromagnet is an AP-pinned structure, which could function as layer 206, as described in Applicants' specification on page 6, lines 16-21). Thus in Nagahama, as described in paragraph 69, layer 2 is one ferromagnetic layer, layer 11 is the other ferromagnetic layer, and layer 12 is the antiferromagnetic coupling layer which renders the magnetizations of ferromagnetic layers 2 and 11 to be antiparallel.

In contrast, Applicants' layers 204-205-206 are *not* an artificial antiferromagnet. Antiferromagnetic layer 205 is *in direct contact* with ferromagnetic layer 206 and pins the magnetization of ferromagnetic layer 206 by the conventional direct antiferromagnetic effect. There is no intermediate antiferromagnetic coupling layer. Layer 204 is a unique underlayer for a specific type of antiferromagnetic layer 205 that enables layer 205 to be made much thinner, which is a key aspect of Applicants' invention, as will be explained below relative to claims 22-23.

Moreover, even if Nagahama's layer 12 in Fig. 5 were an underlayer located beneath a "chemically-ordered alloy comprising X and Mn and having a tetragonal crystalline structure" as in Applicants' claims 1 and 9, it does not teach a "substantially-chemically-ordered alloy having a tetragonal crystalline structure, the alloy selected from the group consisting of alloys of AuCu, FePt, FePd, AgTi3, PtZn, PdZn, IrV, CoPt and PdCd, said underlayer alloy further comprising at least one element selected from the group consisting of Pd, Fe, Pt, and Rh" as asserted in the Office Action. Specifically, paragraph 69 of Nagahama merely states that layer 12 may contain "Au, Ag, Cu, Cr, Pt, Pd, Ir, Ru, Rh or an alloy of these metals". Thus Nagahama does not teach that Pd, Fe, Pt, and Rh can be added to a chemically-ordered alloy having a tetragonal crystalline structure and selected from the group consisting of alloys of AuCu, FePt, FePd, AgTi3, PtZn, PdZn, IrV, CoPt and PdCd. Because Nagahama adds nothing to the teaching of Fukuzawa, the Examiner's previous allowance of claims 1 and 9 should thus be re-instated.

In summary, because Nagahama does not teach that for which it is asserted in the Office

Action, a *prima facie* case of obviousness has not been established. Applicants believe that claims 1-2, 4-15, and 17-21 are allowable, as previously indicated by the Examiner.

Claims 22 and 23, which are directed *not* to a CIP device like Fukuzawa, but to a *CPP device*, have also been rejected over the combination of Fukuzawa and Nagahama. Applicants will re-state their previous explanation as to why claims 22 and 23 are not obvious over Fukuzawa, either alone or in combination with Nagahama.

Independent claim 22 is directed to a *current-perpendicular-to-the-plane (CPP)* magnetoresistive read head that requires a substantially-*chemically-ordered AuCu alloy having a tetragonal crystalline structure and a thickness between about 10 and 200 Angstroms* in contact with a substantially-*chemically-ordered PtMn alloy having a tetragonal crystalline structure and a thickness less than approximately 125 Angstroms*. Dependent claim 23 further limits the thickness of the PtMn alloy *to between about 25 and 50 Angstroms.*

As the Examiner correctly pointed out in the previous Office Action of 01/22/2007, Fukuzawa fails to specifically disclose that "the thickness of the PtMn alloy antiferromagnetic layer is less than approximately 125 Angstroms", and thus most definitely not that the thickness is between about 25 and 50 Angstroms. In this most recent office Action, the Examiner refers to paragraph 38 of Fukuzawa, which merely states that the antiferromagnetic layer is "at most" 200 Angstroms. This is not a teaching of a specific range of thicknesses. However, as the Examiner correctly points out, it is well known that thickness ranges are considered to be within the level of ordinary skill in the art and the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range, citing *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990). In this regard, the specification clearly explains the unexpected criticality of the thickness ranges for a *CPP read head*. The problem is stated at page 3, lines 20-23:

> In CPP sensors, *the large thickness of the PtMn antiferromagnetic layer is a disadvantage* because the high resistivity of PtMn reduces the sensor magnetoresistance (the deltaR/R measurable by the sensor) for a given sense current, or requires that a relatively high sense current be used in the sensor to achieve the desired magnetoresistance.

The specification further states (page 6, line 29 to page 7, line 10) that in the prior art the PtMn is required to be at least 150 Angstroms thick to achieve its antiferromagnetic property, but that as

a result of annealing in contact with a AuCu underlayer, its thickness can unexpectedly be reduced to 50 Angstroms:

> In the preferred embodiment the antiferromagnetic layer is *chemically-ordered equiatomic $Pt_{50}Mn_{50}$ located on and in direct contact with an underlayer of chemically-ordered equiatomic $Au_{50}Cu_{50}$*. The two layers are deposited by magnetron or ion-beam sputtering. After all the layers in the sensor are deposited the sensor is subjected to annealing for 4 hours at 250 °C. *As a result of thermally-activated atomic diffusion, the AuCu underlayer transforms to the $L1_0$ phase and helps the PtMn with which it is in contact to also transform to the $L1_0$ phase. When formed on a AuCu underlayer having a thickness between approximately 10 and 200 Å, the PtMn layer can be as thin as 50 Å*, preferably in the range of 25 to 50 Å, and still transform to the $L1_0$ phase and thus generate the required exchange-bias in the antiferromagnetic layer. *When the PtMn is formed on a conventional underlayer, such as Ta or NiFeCr, it is required to be approximately 150 Å thick.*

It is important to note that Fukazawa does not relate to CPP read heads and is directed solely to *CIP read heads*, as is apparent from Fig. 10. Thus not only does Fukuzawa not teach or suggest any unexpected reduction in thickness of PtMn when used with a AuCu underlayer, there is no motivation for Fukuzawa to reduce the PtMn thickness because there would be *no benefit in doing so in a CIP head*. Thus, there is no validity to the argument that in view of Fukuzawa, which relates to CIP heads and which teaches no thickness ranges for a PtMn antiferromagnetic layer in contact with a AuCu underlayer , it would be obvious to select the reduced thickness ranges for a CPP head as claimed by Applicants in new claims 22-23. For these reasons Applicants believe that claims 22 and 23 are also allowable.

In view of the above amendments and comments Applicants believe all remaining claims are in condition for allowance. The Examiner is invited to call Applicants' attorney if a telephone conference will expedite the prosecution of this application.

Respectfully submitted,

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